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Kramer Electronics, Ltd.

USER MANUAL

Model:

VS-44HD

4x4 SD/HD-SDI Matrix Switcher

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1 Introduction

Welcome to Kramer Electronics! Since 1981, Kramer Electronics has been providing a world of unique, creative, and affordable solutions to the vast range of problems that confront the video, audio, presentation, and broadcasting professional on a daily basis. In recent years, we have redesigned and upgraded most of our line, making the best even better! Our 1,000-plus different models now appear in 11 groups[1] that are clearly defined by function.

Congratulations on purchasing your Kramer **VS-44HD** *4x4 SD/HD-SDI Matrix Switcher*. This product is ideal for:

- Professional broadcasting and production studios
- Presentation applications

The package includes the following items:

- **VS-44HD** *4x4 SD/HD-SDI Matrix Switcher*
- Null-modem adapter, infrared remote control transmitter and power cord
- This user manual[2]

2 Getting Started

We recommend that you:

- Unpack the equipment carefully and save the original box and packaging materials for possible future shipment
- Review the contents of this user manual
- Use Kramer high performance high resolution cables[3]

2.1 Quick Start

This quick start chart summarizes the basic steps when connecting a **VS-44HD**:

1 GROUP 1: Distribution Amplifiers; GROUP 2: Switchers and Matrix Switchers; GROUP 3: Control Systems; GROUP 4: Format/Standards Converters; GROUP 5: Range Extenders and Repeaters; GROUP 6: Specialty AV Products; GROUP 7: Scan Converters and Scalers; GROUP 8: Cables and Connectors; GROUP 9: Room Connectivity; GROUP 10: Accessories and Rack Adapters; GROUP 11: Sierra Products

2 Download up-to-date Kramer user manuals from the Internet at this URL: http://www.kramerelectronics.com

3 The complete list of Kramer cables is on our Web site at http://www.kramerelectronics.com

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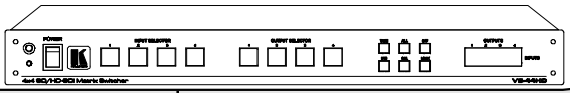
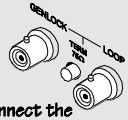
Step 1: Mount the machine

Mount the machine in a rack or stick the 4 rubber feet to the underside



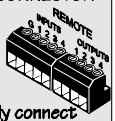
Step 2: Connect the inputs and outputs - see section 6

Connect a GENLOCK source



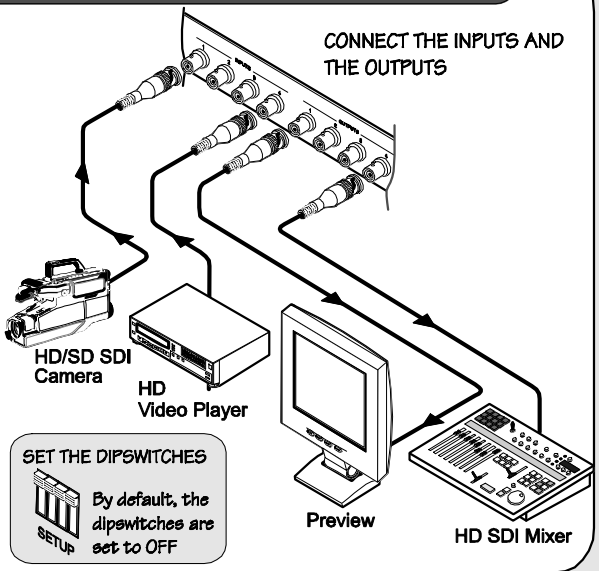
Connect the LOOP connector

CONTROL VIA THE REMOTE CONNECTOR



STEP I
Temporarily connect an OUTPUT PIN to PIN G (ground)

STEP II
Temporarily connect an INPUT PIN to PIN G (ground)



SET THE DIPSWITCHES

By default, the dipswitches are set to OFF

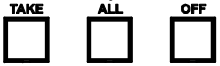
Step 3: Turn the power ON

Step 4: Operate the machine - see section 7

Uee the SELECTOR buttons to switch the inpute to the outputs

Prese TAKE to confirm actions

Connect a selected input to ALL the outputs; dieconnect an output (OFF) from an input



Store (STO) and recall (RCL) the status

LOCK the front panel

Operate via the front panel buttons, RS-232, RS-485 and the Ethernet

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3 Overview

The **VS-44HD** is a true 4x4 matrix switcher[1] for standard definition / high definition SDI signals that lets you simultaneously route any of the four inputs to any or all of the four outputs. It can be used as a 4x4 SD/HD-SDI matrix switcher or as a dual-link 2x2 SD/HD-SDI Matrix switcher. The **VS-44HD** features:

- Input and output signals on BNC connectors and selector buttons that automatically light up in different colors—green, when the **VS-44HD** detects a 'standard definition' signal, or blue, when it detects a 'high definition' signal
- Reclocking and equalization on each input
- The ability to switch genlocked video signals according to timing of the GENLOCK reference input. Switching according to the Bi-level or Tri-level Genlock input according to SMPTE RP-168[2]
- Factory reset that lets you reset the machine to its original default state
- The storing and recalling of setups, a Take button for the execution of multiple switches all at once, and a front panel lock

The **VS-44HD** is housed in a 19" 1U rack mountable enclosure and is fed from a 100-240 VAC universal switching power supply. Control is via the front panel buttons, infrared remote control transmitter, and/or remotely, by RS 232 or RS 485 serial commands transmitted by a touch screen system, PC, or other serial controller, as well as ETHERNET or remote contact closure for forced operation.

To achieve the best performance:

- Connect only good quality connection cables, thus avoiding interference, deterioration in signal quality due to poor matching, and elevated noise levels (often associated with low quality cables)
- Avoid interference from neighboring electrical appliances that may adversely influence signal quality and position your Kramer **VS-44HD** away from moisture, excessive sunlight and dust

4 Your VS-44HD 4x4 SD/HD-SDI Matrix Switcher

Figure 1, Table 1, and Table 2 define the **VS-44HD** *4x4 SD/HD-SDI Matrix Switcher*.

1 Switching is implemented during the vertical interval period according to the SMPTE RP-168 standard, when using synchronized SDI sources

2 The sources must be genlocked to the GENLOCK input in order to switch cleanly

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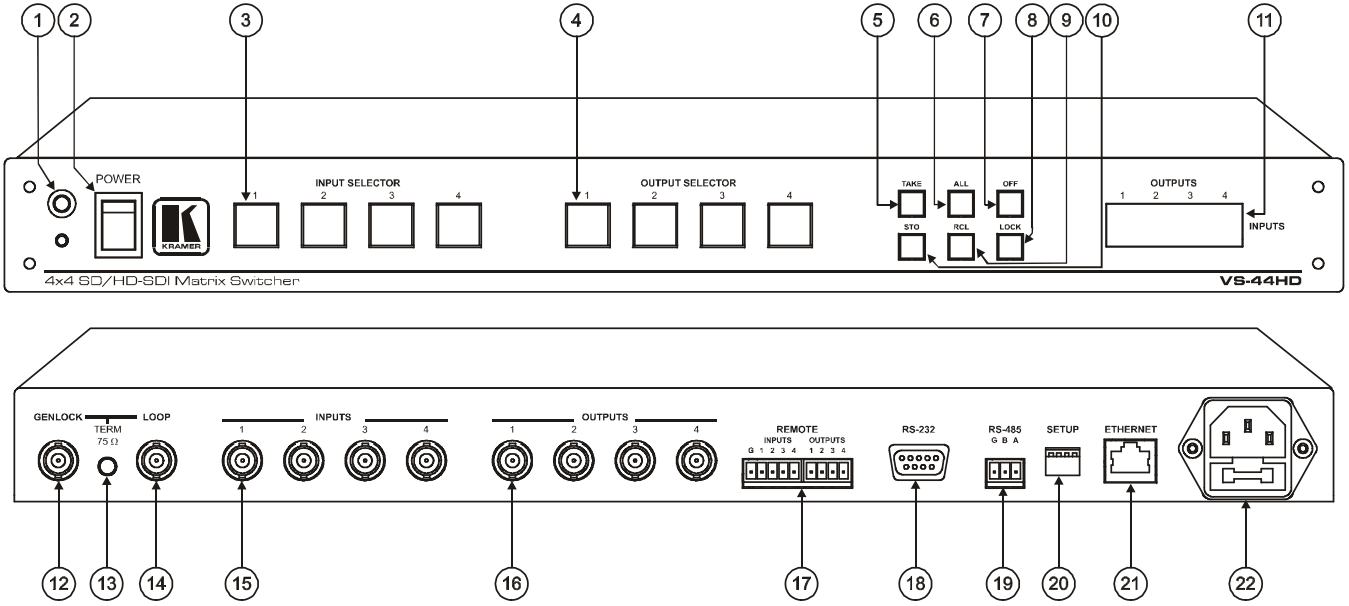

Figure 1: VS-44HD 4x4 SD/HD-SDI Matrix Switcher

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Table 1: Front Panel VS-44HD 4x4 SD/HD-SDI Matrix Switcher

#	Feature	Function
1	IR Receiver	The red LED illuminates when receiving signals from the infrared remote control transmitter
2	*POWER* Switch	Illuminated switch for turning the unit ON or OFF
3	*INPUT SELECTOR* Buttons	Select the input to switch to the output (from 1 to 4). In the dual-link mode, select input 1 or 2 to switch dual-link 1 or 2 to the outputs Press input buttons 1, 2 and 3 simultaneously, to reset the machine to its factory default values[1] (see section 6.7) Use to set the resolution when switching genlocked video signals (see section 6.8)
4	*OUTPUT SELECTOR* Buttons	Select the output to which the input is switched (from 1 to 4). In the dual-link mode, select the dual-link output 1 or 2 to which the input is switched
5	*TAKE* Button	Pressing *TAKE* toggles the mode between the *CONFIRM* mode[2] and the *AT ONCE* mode (user confirmation per action is unnecessary)
6	*ALL* Button	Pressing *ALL* followed by an *INPUT* button, connects that input to all outputs[3]
7	*OFF* Button	An *OFF-OUT* combination disconnects that output from the inputs; an *OFF-ALL* combination disconnects all the outputs
8	*LOCK* Button	Disengages the front panel buttons
9	*RCL* (*RECALL*) Button	Pressing the *RCL* button and the corresponding INPUT / OUTPUT key recalls a setup from the non-volatile memory. The stored status blinks. Pressing a different INPUT / OUTPUT button lets you view[4] another setup. After making your choice, pressing the *RCL* button again implements the new status
10	*STO* (STORE) Button	Pressing STO followed by an INPUT / OUTPUT button stores the current setting[5]
11	7-segment Display	Displays the selected input switched to the output (marked above each input)

Table 2: Rear Panel VS-44HD 4x4 SD/HD-SDI Matrix Switcher

#	Feature	Function
12	*GENLOCK* BNC Connector	Connect to the Genlock source
13	*TERM* Button	Press to terminate the Genlock source (75Ω) or release for looping[6]
14	*LOOP* BNC Connector	Connect to the GENLOCK connector of the next unit in the line
15	*INPUT* BNC Connectors	Connect to the serial digital video sources
16	*OUTPUT* BNC Connectors	Connect to the serial digital video acceptors
17	REMOTE Terminal Block Connector	Connect to closure contact switches
18	*RS-232* DB 9F Port	Connects to the PC or the Remote Controller[7]
19	*RS-485* Detachable Terminal Block Port	Pin G is for the Ground connection[8]; pins B (-) and A (+) are for RS-485
20	SETUP Dipswitches	Dipswitches for setup of the unit
21	ETHERNET Connector	Connects to the PC or other Serial Controller via computer networking
22	Power Connector with Fuse	AC connector enabling power supply to the unit

1 The 7-segmant display shows 1234 indicating that the operation mode is normal, and that the setups stored via the INPUT/OUTPUT buttons have been erased

2 When in Confirm mode, the TAKE button illuminates

3 For example, press ALL and then Input button # 2 to connect input # 2 to all the outputs

4 Only view, nothing is implemented at this stage

5 For example, press STO and then the Output button # 3 to store in Setup # 3

6 Push in to terminate the input. Release when the input extends to another unit

7 Via a null-modem connection

8 The ground connection is sometimes connected to the shield of the RS-485 cable. In most applications, the ground is not connected

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5 Installing on a Rack

This section describes what to do before installing on a rack and how to rack mount.

Before Installing in a Rack

Before installing in a rack, be sure that the environment is within the recommended range:	
Operating temperature range	+5° to +45° C (41° to 113° F)
Operating humidity range	10 to 90% RHL, non-condensing
Storage temperature range	-20° to +70° C (-4° to 158° F)
Storage humidity range	5 to 95% RHL, non-condensing

CAUTION!!

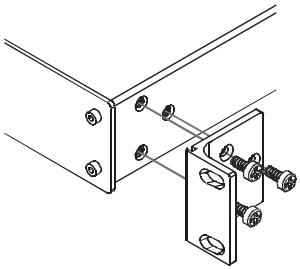
When installing on a 19" rack, avoid hazards by taking care that:

1. It is located within the recommended environmental conditions, as the operating ambient temperature of a closed or multi unit rack assembly may exceed the room ambient temperature.
2. Once rack mounted, enough air will still flow around the machine.
3. The machine is placed straight in the correct horizontal position.
4. You do not overload the circuit(s). When connecting the machine to the supply circuit, overloading the circuits might have a detrimental effect on overcurrent protection and supply wiring. Refer to the appropriate nameplate ratings for information. For example, for fuse replacement, see the value printed on the product label.
5. The machine is earthed (grounded) in a reliable way and is connected only to an electricity socket with grounding. Pay particular attention to situations where electricity is supplied indirectly (when the power cord is not plugged directly into the socket in the wall), for example, when using an extension cable or a power strip, and that you use only the power cord that is supplied with the machine.

How to Rack Mount

To rack-mount a machine:

1. Attach both ear brackets to the machine. To do so, remove the screws from each side of the machine (3 on each side), and replace those screws through the ear brackets.



2. Place the ears of the machine against the rack rails, and insert the proper screws (not provided) through each of the four holes in the rack ears.

Note that:

- **In some models, the front panel may feature built-in rack ears**
- Detachable rack ears can be removed for desktop use
- Always mount the machine in the rack before you attach any cables or connect the machine to the power
- If you are using a Kramer rack adapter kit (for a machine that is not 19"), see the Rack Adapters user manual for installation instructions (you can download it at: http://www.kramerelectronics.com)

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6 Connecting Your VS-44HD

This section describes how to connect the **VS-44HD** as a:

- 4x4 SD/HD SDI Matrix Switcher, see section 6.1
- Dual-Link 2x2 SD/HD-SDI Matrix Switcher, see section 6.2

6.1 Connecting Your VS-44HD 4x4 SD/HD-SDI Matrix Switcher

You can use your **VS-44HD** to switch one of the four standard definition / high definition SDI inputs to any or all of the four standard definition / high definition SDI outputs, as the example in Figure 2 shows.

To connect the **VS-44HD** *4x4 SD/HD-SDI Matrix Switcher*, do the following[1]:

1. Connect up to four SDI sources to the SDI INPUT BNC connectors (for example, an HD/SD SDI camera to input 1 and an HD video player to input 4).
2. Connect the SDI OUTPUT BNC connectors to up to[2] four SDI acceptors (for example, output 1 to a Preview monitor, and output 4 to an HD SDI mixer).
3. Set the dipswitches (see section 6.4).
4. As an option[3], connect:
   - A Genlock source to the GENLOCK BNC connector
   - The LOOP BNC connector to the GENLOCK connector of the next unit in the line, and release the TERM button for looping[4]
5. Connect a PC and/or controller (if required), to the:
   - RS-232 port (see section 6.5), and/or
   - RS-485 port (see section 6.6), and/or
   - ETHERNET connector (see section 6.9)
6. As an option[3], connect a remote contact closure switch (refer to section 6.10)
7. Connect the power cord[5].

1 Switch OFF the power on each device before connecting it to your VS-44HD. After connecting your VS-44HD, switch on its power and then switch on the power on each device

2 When only one output is required, connect that output, and leave the other outputs unconnected

3 Not illustrated in Figure 2

4 Pushed in terminates the input. Release when the input extends to another unit

5 We recommend that you use only the power cord that is supplied with this machine

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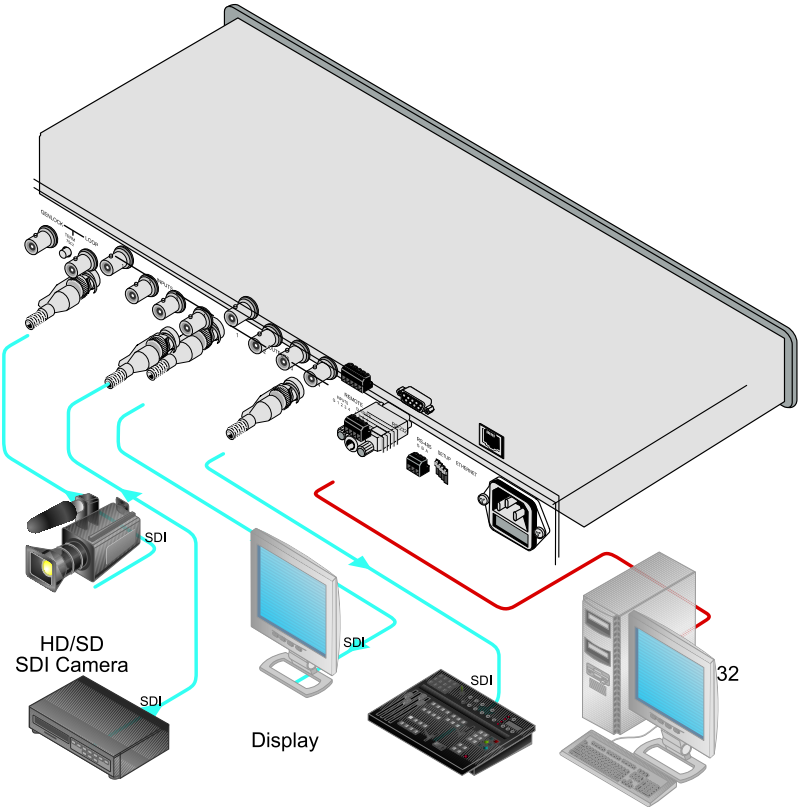

Figure 2: Connecting the VS-44HD 4x4 SD/HD-SDI Matrix Switcher

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6.2 Connecting the VS-44HD as a Dual-Link 2x2 SD/HD-SDI Matrix Switcher

You can use your **VS-44HD** in the dual-link mode to switch either of the two dual-link SDI inputs, input 1 and 2, or input 3 and 4, to one or both of the two dual-link SDI outputs, output 1 and 2, and/or output 3 and 4, as the example in Figure 3 shows.

To connect the **VS-44HD** as a dual-link 2x2 SD/HD-SDI Matrix switcher, do the following[1]:

1. Connect up to two SDI sources to the SDI INPUT BNC connectors (for example, an HD/SD SDI camera to inputs 1 and 2, and an HD video player to inputs 3 and 4).
2. Connect the SDI OUTPUT BNC connectors to up to[2] two SDI acceptors (for example, outputs 1 and 2 to a Preview monitor, and outputs 3 and 4 to an HD SDI mixer).
3. Follow steps 3 to 7 in section 6.1.
4. Set the machine to the dual-link mode, see section 6.3.

1 Switch OFF the power on each device before connecting it to your VS-44HD. After connecting your VS-44HD, switch on its power and then switch on the power on each device

2 When only one output is required, connect that output, and leave the other outputs unconnected

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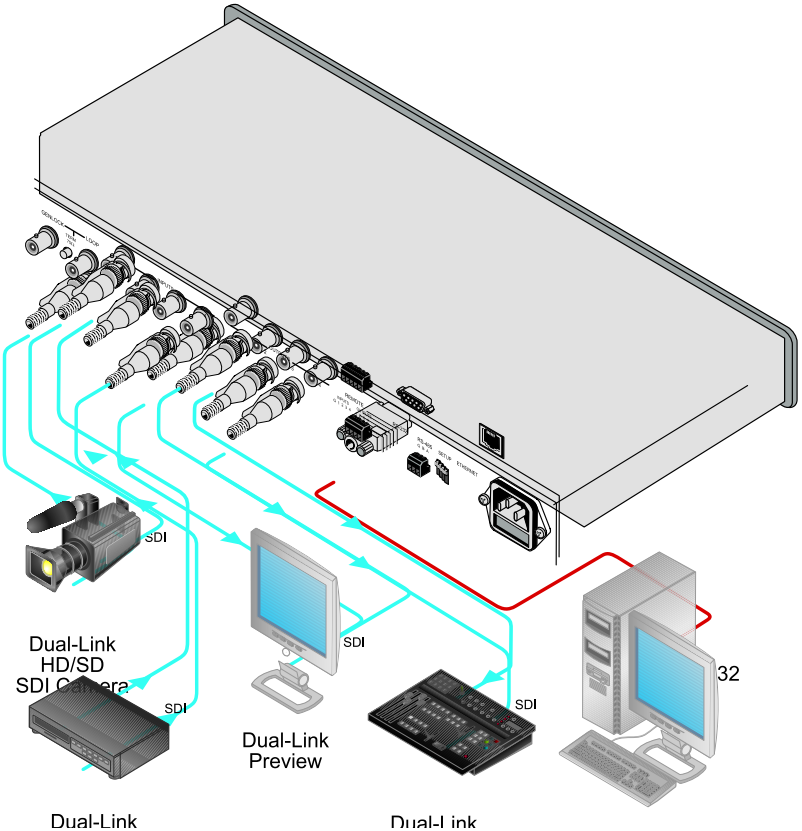

Figure 3: Connecting the VS-44HD as a Dual-Link 2x2 SD/HD-SDI Matrix Switcher

6.3 Setting the VS-44HD to work in the Dual-Link Mode

You can set the **VS-44HD** to work in the dual-link mode as follows:

To switch to the dual-link mode, press and hold the OFF front panel button for 3 seconds until a red dot illuminates on the display (on the second segment of the 7-segment display) and the OFF button blinks

To exit the dual-link mode, press and hold the OFF front panel button for 3 seconds until the red dot on the display disappears and the OFF button blinks.

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6.4 Dipswitch Settings

By default, all dipswitches are set to OFF.

Figure 4 illustrates the **VS-44HD** dipswitches:

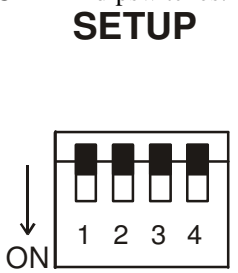

Figure 4: VS-44HD SETUP Dipswitches

6.4.1 Setting the Machine # Dipswitches

The Machine # determines the position of a **VS-44HD** unit, specifying which **VS-44HD** unit is being controlled when several **VS-44HD** units connect to a PC or serial controller. Set the Machine # on a **VS-44HD** unit via SETUP DIPS 1, 2, 3 and 4, according to Table 3.

When using a standalone **VS-44HD** unit, set the Machine # to 1. When connecting more than one **VS-44HD** unit, set the first machine (the Master) that is closest to the PC, as Machine # 1 (dipswitches are set to OFF).

Table 3: Machine # Dipswitch Settings

Mach. #	DIP 1	DIP 2	DIP 3	DIP 4
1	OFF	OFF	OFF	OFF
2	OFF	OFF	OFF	ON
3	OFF	OFF	ON	OFF
4	OFF	OFF	ON	ON
5	OFF	ON	OFF	OFF
6	OFF	ON	OFF	ON
7	OFF	ON	ON	OFF
8	OFF	ON	ON	ON

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6.5 Controlling via RS-232 (for example, using a PC)

To connect a PC to the **VS-44HD** unit, using the Null-modem adapter provided with the machine (recommended):

- Connect the RS-232 DB9 rear panel port on the **VS-44HD** unit to the Null-modem adapter and connect the Null-modem adapter with a 9 wire flat cable to the RS-232 DB9 port on your PC

To connect a PC to the **VS-44HD** unit, without using a Null-modem adapter:

- Connect the RS-232 DB9 port on your PC to the RS-232 DB9 rear panel port on the **VS-44HD** unit, as Figure 5 illustrates

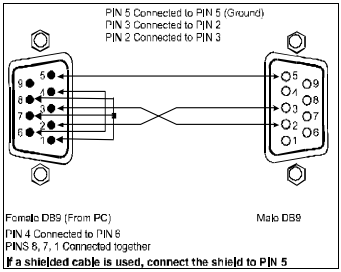
PIN 5 Connected to PIN 5 (Ground)
PIN 3 Connected to PIN 2
PIN 2 Connected to PIN 3
Female DB9 (From PC)
Male DB9
PIN 4 Connected to PIN 6
PINS 8, 7, 1 Connected together
If a shielded cable is used, connect the shield to PIN 5

Figure 5: Connecting a PC without using a Null-modem Adapter

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6.6 Controlling via the RS-485 Port

To cascade up to eight individual **VS-44HD** units, via RS-485 (with control via a Master Programmable Remote Control system such as the Kramer **RC-3000**), as Figure 6 illustrates, do the following:

1. Connect the "A" (+) and "B" (-) PINS on the RS-485 terminal block port of the **RC-3000** to the "A" (+) and "B" (-) PINS, respectively, on each of the eight **VS-44HD** units. (If using shielded twisted pair cable, the shield is usually connected to the "G" (Ground) PIN of the first unit).
2. Set the first **VS-44HD** unit as MACHINE # 1 and the following seven **VS-44HD** units as MACHINE # 2 to MACHINE # 8, according to Table 3.

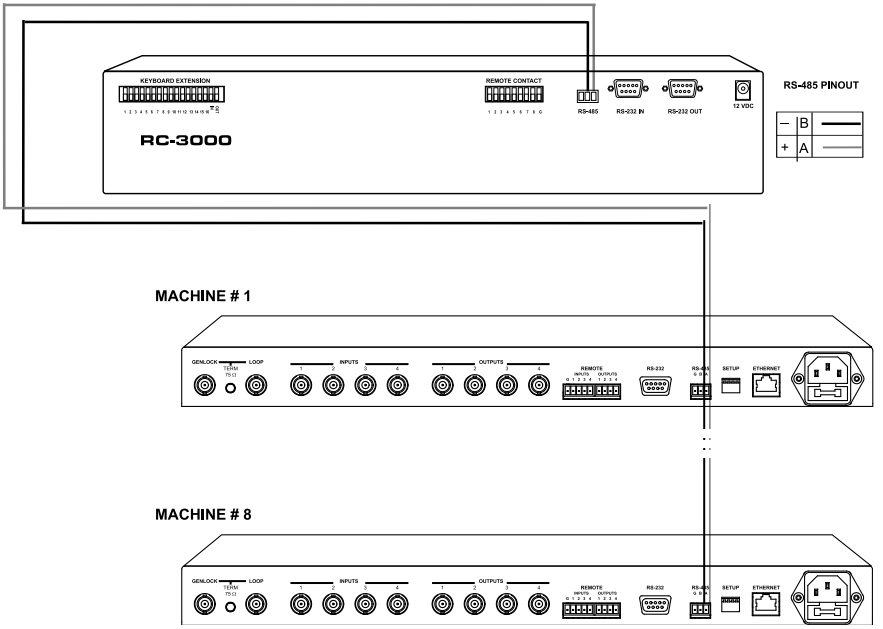

Figure 6: Controlling via RS-485 (for example, using an RC-3000)

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6.7 Factory Reset

Press and hold the input buttons 1, 2 and 3 simultaneously for 3 seconds until the three buttons flash to reset the machine to its default values.

6.8 Switching Genlocked Video Signals

The genlock feature lets you switch genlocked video signals according to timing of the GENLOCK reference input[1].

Connect the GENLOCK cable.

If the HD input signal[2] that is connected is one of the following, it is necessary to set it up as follows:

- 1080i@60Hz: press and hold INPUT 1 button for 3 seconds. The button will flash[3] to indicate that the set up was completed
- 1080i@50Hz or 720p@50Hz: press and hold INPUT 2 button for 3 seconds.
  The button will flash[3] to indicate that the set up was completed
- 720p@60Hz: press and hold INPUT 3 button for 3 seconds.
  The button will flash[3] to indicate that the set up was completed

When turning the machine ON, the appropriate button will flash to indicate the latest setup (last setup is saved).

6.9 Controlling via ETHERNET

You can connect the **VS-44HD** via the Ethernet, using a crossover cable (see section 6.9.1) for direct connection to the PC or a straight through cable (see section 6.9.2) for connection via a network hub or network router.

6.9.1 Connecting the ETHERNET Port directly to a PC (Crossover Cable)

You can connect the Ethernet port of the **VS-44HD** to the Ethernet port on your PC, via a crossover cable with RJ-45 connectors.

This type of connection is recommended for identification of the factory default IP Address of the **VS-44HD** during the initial configuration

After connecting the Ethernet port, configure your PC as follows:

1. Right-click the My Network Places icon on your desktop.

1 According to SMPTE RP-168. The sources must be genlocked to the GENLOCK input in order to switch cleanly

2 The unit will detect automatically when SD-SDI inputs are used

3 If a change is made to the resolution or refresh rate. The button will not flash if the new timing is the same as that previously selected

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2. Select **Properties**.
3. Right-click Local Area Connection Properties.
4. Select **Properties**.
   The Local Area Connection Properties window appears.
5. Select the Internet Protocol (TCP/IP) and click the **Properties** Button (see Figure 7).

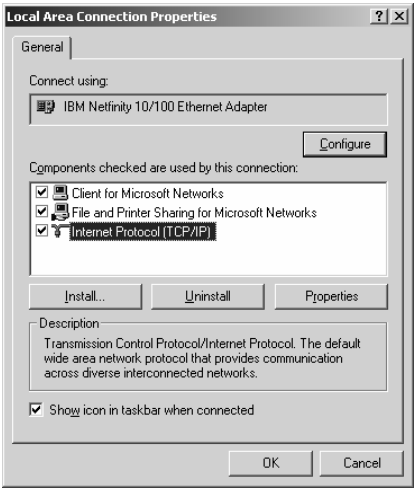

Figure 7: Local Area Connection Properties Window

6. Select Use the following IP address, and fill in the details as shown in Figure 8.
7. Click **OK**.

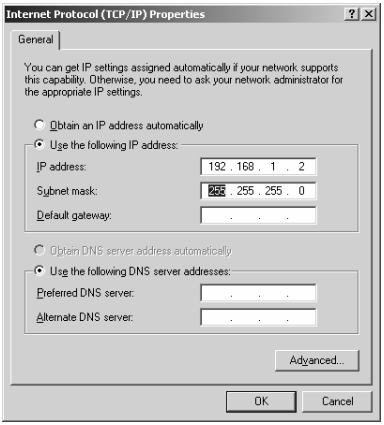
Internet Protocol (TCP/IP) Properties
General
You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.
Obtain an IP address automatically
Use the following IP address:
IP address: 192 . 168 . 1 . 2
Subnet mask: 255 . 255 . 255 . 0
Default gateway:
Obtain DNS server address automatically
Use the following DNS server addresses:
Preferred DNS server:
Alternate DNS server:
Advanced...
OK
Cancel

Figure 8: Internet Protocol (TCP/IP) Properties Window

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6.9.2 Connecting the ETHERNET Port via a Network Hub (Straight-Through Cable)

You can connect the Ethernet port of the **VS-44HD** to the Ethernet port on a network hub or network router, via a straight-through cable with RJ-45 connectors.

6.9.3 Configuring the Ethernet Port

After connecting the Ethernet port, you have to install and configure it.

For detailed instructions on how to install and configure your Ethernet port, see the "Ethernet Configuration (FC-11) guide.pdf" on our Web site: http://www.kramerelectronics.com.

6.10 Controlling via the REMOTE Connector

Connecting the *REMOTE* terminal block connector to a contact closure switch enables you to route an input to an output by remote control. For example, to route input 1 to output 4, as the example in Figure 9 illustrates, momentarily touch, firstly, output # 4 to the Ground, and then secondly, input # 1 to the Ground.

In the dual-link mode, only inputs and outputs 1 and 2 are used (as are the INPUT and OUTPUT selector buttons). Remote PINs 3 and 4 and Selector buttons 3 and 4 are not used.

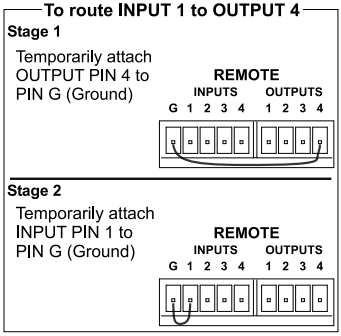

Figure 9: Using the REMOTE Connector

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7 Operating the VS-44HD

You can operate your **VS-44HD** via:

- The front panel buttons
- RS-232/RS-485 serial commands transmitted by a PC, touch screen system, or other serial controller
- The Kramer infrared remote control transmitter
- The ETHERNET

7.1 Switching OUT-IN Combinations

To switch an input to an output via the front panel buttons[1], in the AT ONCE mode (see section 7.3), do the following:

1. Press an OUTPUT button (1, 2, 3, 4 or ALL).
   The selected OUTPUT button illuminates brightly, as does the 7-segment display.
2. Press an INPUT button (1, 2, 3, 4 or OFF)[2].
   The selected input switches to the selected output. The digits displayed in the 7-segment display change as appropriate.
   After a few seconds the selected OUTPUT button switches OFF and the OUTPUT buttons illuminate according to the signal routed to the relevant output.

Note that:

- The OUTPUT button color changes during routing according to the color of the input button: green (for standard definition) or blue (for high definition)
- If an OUTPUT button is not selected, that button will not illuminate
- If an OUTPUT is connected to the input with no signal connected, that OUTPUT button will not illuminate

7.2 Switching OUT-IN Combinations in the Dual-Link Mode

To switch an input to an output in the Dual-Link Mode via the front panel buttons[1], in the AT ONCE mode (for immediate switching), do the following:

1. Press an OUTPUT button (either 1, 2 or ALL).
   The selected OUTPUT button illuminates brightly, as does the 7-segment display.

1 For details of how to route an input to an output using the REMOTE connector, see section 6.10

2 For immediate switching

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2. Press an INPUT button (either 1, 2 or OFF).
   The selected input switches to the selected output, and that input button illuminates brightly. The digits displayed in the 7-segment display change as appropriate.

7.3 Confirming Settings

Choose to work in the AT ONCE or the CONFIRM mode (see section 7.3.1). When the **VS-44HD** operates in the AT ONCE mode, pressing an OUT-IN combination implements the switch immediately. In the CONFIRM mode, the TAKE button must be pressed to authorize the switch.

In the AT ONCE mode, you save time as execution is immediate and actions require no user confirmation. However, no protection is offered against changing an action in error.

In the CONFIRM mode:

- You can key-in several actions and then confirm them by pressing the "TAKE" button, to simultaneously activate the multiple switches
- Every action requires user confirmation, protecting against erroneous switching
- Execution is delayed until the user confirms the action

Note that after ten seconds the **VS-44HD** will go to standby mode and the buttons and the 7-segment display will illuminate less brightly

7.3.1 Toggling between the AT ONCE and CONFIRM Modes

To toggle between the AT ONCE and CONFIRM modes, do the following:

1. Press the dim TAKE button to toggle from the AT ONCE mode (in which the TAKE button is dim) to the CONFIRM mode (in which the TAKE button illuminates).
   Actions now require user confirmation and the TAKE button illuminates.
2. Press the illuminated TAKE button to toggle from the CONFIRM mode back to the AT ONCE mode.
   Actions no longer require user confirmation and the TAKE button no longer illuminates.

7.3.2 Confirming a Switching Action

To confirm a switching action (in CONFIRM mode- where the TAKE button is illuminated), do the following:

1. Press an OUT-IN combination.
   The 7-segment Display blinks[1].

1 The timeout lasts for 10 seconds

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2. Press the TAKE button to confirm the action.
   The 7-segment Display no longer blinks. The TAKE button illuminates.

To confirm several actions (in CONFIRM mode), do the following:

1. Press each OUT-IN combination in sequence.
   The 7-segment Display blinks.
2. Press the TAKE button to confirm all the actions.
   The 7-segment Display no longer blinks. The TAKE button illuminates.

7.4 Storing/Recalling Input/Output Configurations

You can store and recall up to eight setup configurations using the four INPUT buttons and the four OUTPUT buttons.

7.4.1 Storing an Input/Output Configuration

To store the current status in memory, do the following:

1. Press the STO button.
   The STO button illuminates.
2. Press one of the 8 INPUT / OUTPUT buttons (this will be the setup # in which the current status is stored).
   The selected INPUT / OUTPUT button illuminates in blue. The memory stores the data at that reference.

7.4.2 Recalling an Input/Output Configuration

To recall an input/output configuration, do the following:

1. Press the RCL button.
   The RCL button illuminates.
2. Press the appropriate INPUT / OUTPUT button (the button # corresponding to the setup #). That setup configuration will blink in the 7-segment Display.
   The memory recalls the stored data from that reference.
   After pressing the same memory location the second time, the settings will take effect.

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7.5 Locking the Front Panel

To prevent changing the settings accidentally or tampering with the unit via the front panel buttons, lock your **VS-44HD**. Unlocking releases the protection mechanism.

To lock the **VS-44HD**:

- Press the LOCK button for three seconds, until the LOCK button is illuminated.
  The front panel is locked. Pressing a button will have no effect

To unlock the **VS-44HD**:

- Press the illuminated LOCK button until the LOCK button is no longer illuminated
  The front panel unlocks

8 Technical Specifications

Table 4 includes the technical specifications:

Table 4: Technical Specifications[1] *of the VS-44HD 4x4 SD/HD-SDI Matrix Switcher*

INPUTS:	4 SDI SMPTE-259M, 292M, 344M serial video, 75 ohms on BNC connectors 1 GENLOCK 75Ω / Hi-Z on a BNC connector
OUTPUTS:	4 equalized and reclocked SMPTE-259M, 292M, 344M outputs 75 ohms on BNC connectors 1 Looped GENLOCK 75Ω / Hi-Z on a BNC connector
MAX. OUTPUT LEVEL:	800mVpp /75 ohms
DATA RATE:	Up to 1.485Gbps
CONTROLS:	Front-panel, RS-232; RS-485, ETHERNET, infrared remote, contact closure, and panel lock
POWER SOURCE:	Universal, 100-240VAC, 50/60Hz 22VA
DIMENSIONS:	19 inch (W), 7 inch (D), 1U (H) rack mountable
WEIGHT:	2.6 kg. (5.7 lbs.) approx.
ACCESSORIES:	Power cord, Null-modem Adapter

9 Table of Hex Codes for Serial Communication

Table 5 lists the Hex values for a single machine (*MACHINE #* 1):

Table 5: VS-44HD Hex Codes for Switching via RS-232/RS-485

IN/OUT 1	IN/OUT 2	IN/OUT 3	IN/OUT 4
01	01	01	01
81	82	83	84
81	81	81	81
81	81	81	81

1 Specifications are subject to change without notice

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10 Kramer Protocol 2000

The **VS-44HD** is compatible with Kramer's Protocol 2000 (version 0.46) (below). This RS-232/RS-485 communication protocol uses four bytes of information as defined below. For RS-232, a null-modem connection between the machine and controller is used. The default data rate is 9600 baud, with no parity, 8 data bits and 1 stop bit.

Table 6: Protocol Definitions

MSB							LSB
	DESTI-NATION	**INSTRUCTION**					
0	D	N5	N4	N3	N2	N1	N0
7	6	5	4	3	2	1	0
1st byte							
	INPUT						
1	I6	I5	I4	I3	I2	I1	I0
7	6	5	4	3	2	1	0
2nd byte							
	OUTPUT						
1	O6	O5	O4	O3	O2	O1	O0
7	6	5	4	3	2	1	0
3rd byte							
			MACHINE NUMBER				
1	OVR	X	M4	M3	M2	M1	M0
7	6	5	4	3	2	1	0
4th byte							

1st BYTE: Bit 7 – Defined as 0.
D – "DESTINATION": 0 - for sending information to the switchers (from the PC);
1 - for sending to the PC (from the switcher).
N5…N0 – "INSTRUCTION"
The function that is to be performed by the switcher(s) is defined by the INSTRUCTION (6 bits). Similarly, if a function is performed via the machine's keyboard, then these bits are set with the INSTRUCTION NO., which was performed. The instruction codes are defined according to the table below (INSTRUCTION NO. is the value to be set for N5…N0).

2nd BYTE: Bit 7 – Defined as 1.
I6…I0 – "INPUT".
When switching (ie. instruction codes 1 and 2), the INPUT (7 bits) is set as the input number which is to be switched. Similarly, if switching is done via the machine's front-panel, then these bits are set with the INPUT NUMBER which was switched. For other operations, these bits are defined according to the table.

3rd BYTE: Bit 7 – Defined as 1.
O6…O0 – "OUTPUT".
When switching (ie. instruction codes 1 and 2), the OUTPUT (7 bits) is set as the output number which is to be switched. Similarly, if switching is done via the machine's front-panel, then these bits are set with the OUTPUT NUMBER which was switched. For other operations, these bits are defined according to the table.

4th BYTE: Bit 7 – Defined as 1.
Bit 5 – Don't care.
OVR – Machine number override.
M4…M0 – MACHINE NUMBER.
Used to address machines in a system via their machine numbers. When several machines are controlled from a single serial port, they are usually configured together with each machine having an individual machine number. If the OVR bit is set, then all machine numbers will accept (implement) the command, and the addressed machine will reply.
For a single machine controlled via the serial port, always set M4…M0 = 1, and make sure that the machine itself is configured as MACHINE NUMBER = 1.

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Table 7: Instruction Codes for Protocol 2000

Note: All values in the table are decimal, unless otherwise stated.

INSTRUCTION		DEFINITION FOR SPECIFIC INSTRUCTION		NOTE
#	DESCRIPTION	INPUT	OUTPUT	
0	RESET VIDEO	0	0	1
1	SWITCH VIDEO	Set equal to video input which is to be switched (0 = disconnect)	Set equal to video output which is to be switched (0 = to all the outputs)	2, 15
2	SWITCH AUDIO	Set equal to audio input which is to be switched (0 = disconnect)	Set equal to audio output which is to be switched (0 = to all the outputs)	2
3	STORE VIDEO STATUS	Set as SETUP #	0 - to store 1 - to delete	2, 3, 15
4	RECALL VIDEO STATUS	Set as SETUP #	0	2, 3, 15
5	REQUEST STATUS OF A VIDEO OUTPUT	Set as SETUP #	Equal to output number whose status is reqd	4, 3
6	REQUEST STATUS OF AN AUDIO OUTPUT	Set as SETUP #	Equal to output number whose status is reqd	4, 3
7	VIS SOURCE	Set as input # when OUTPUT byte = 6; OR set as output # when OUTPUT byte = 7; OR set as blank period (in steps of 25ms) when OUTPUT byte = 32; OR set = 0. *****	0 - No VIS (immediate) 1 - Input # 1 2 - External digital sync 3 - External analog sync 4 - Dynamic sync 5 - Inter-machine sync 6 - Input # (INPUT byte) 7 - Output #(INPUT byte) 8 - User-defined sync 32 - RGBHV seamless switching 64 - Set for delayed switch 65 - Execute delayed switch 66 - Cancel delayed switch setting	2, 5, 17, 18
8	BREAKAWAY SETTING	0	0 - audio-follow-video 1 - audio breakaway	2
		1	0 - FOLLOW mode 1 - Normal mode	15
9	VIDEO / AUDIO TYPE SETTING	0 - for video	0 - CV 4 - SDI 1 - YC 5 - CV+YC 2 - YUV 6 - VGA scaler 3 - RGBS 7 - DVI	2
		1 - for audio	O0=0 – Unbalanced audio O0=1 – Balanced audio O1=0 – Digital audio O1=1 – Analog audio O4=0, O3=0, O2=0-Mono O4=0, O3=0,O2=1-Stereo	
		2 - for VGA and DVI	1 - 640X480 2 - 800X600 3 - 1024X768	
10	REQUEST VIS SETTING	Set as SETUP #, or set to 126 or 127 to request if machine has this function	0 - VIS source 1 - Input # or output # of source 2 - Vertical sync freq (Hz)	3, 4, 6, 7
11	REQUEST BREAKAWAY SETTING	Set as SETUP #, or set to 126 or 127 to request if machine has this function	0 - Request audio breakaway setting 1 - Request "FOLLOW" setting	3, 4, 6, 15
12	REQUEST VIDEO / AUDIO TYPE SETTING	Set as SETUP #, or set to 126 or 127 to request if machine has this function	0 - for video 1 - for audio 2 - for VGA	3, 4, 6
13	SET HIGHEST MACHINE ADDRESS	0 - for video 1 - for audio	Set equal to highest machine address	2
14	REQUEST HIGHEST MACHINE ADDRESS	0 - for video 1 - for audio	0	4
15	REQUEST WHETHER SETUP IS DEFINED / VALID INPUT IS DETECTED	SETUP # or Input #	0 - for checking if setup is defined 1 - for checking if input is valid	8

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INSTRUCTION		DEFINITION FOR SPECIFIC INSTRUCTION		NOTE
#	DESCRIPTION	INPUT	OUTPUT	
16	ERROR / BUSY	For invalid / valid input (i.e. OUTPUT byte = 4 or OUTPUT byte = 5), this byte is set as the input #	0 - error 1 - invalid instruction 2 - out of range 3 - machine busy 4 - invalid input 5 - valid input	9, 25
17	RESERVED	- - - -	- - - -	10
18	RESET AUDIO	0	0	1
19	STORE AUDIO STATUS	Set as SETUP #	0 - to store 1 - to delete	2, 3
20	RECALL AUDIO STATUS	Set as SETUP #	0	2, 3
21	SET VIDEO PARAMETER	Equal to input / output number whose video parameter is to be set (0 = all)	Set as parameter value	2, 11, 24
22	SET AUDIO PARAMETER	Equal to input / output number whose gain is to be set (0 = all)	Set as parameter value	2, 11, 24
23	INCREASE / DECREASE VIDEO PARAMETER	Equal to input / output number whose video parameter is to be increased / decreased (0 = all)	0 - increase video gain 1 - decrease video gain 2 - increase contrast 3 - decrease contrast 4 - increase brightness 5 - decrease brightness 6 - increase colour 7 - decrease colour 8 - increase hue 9 - decrease hue 16 - increase H-phase 17 - decrease H-phase 18 - increase V-position 19 - decrease V-position	24
24	INCREASE / DECREASE AUDIO PARAMETER	Equal to input / output number whose parameter is to be increased / decreased (0 = all)	0 - increase output 1 - decrease output 2 - increase left output 3 - decrease left output 4 - increase right output 5 - decrease right output 6 - increase input 7 - decrease input 8 - increase left input 9 - decrease left input 10 - increase right input 11 - decrease right input	24
25	REQUEST AUDIO PARAMETER	Equal to input / output number whose parameter is requested	0	6, 24
26	REQUEST VIDEO PARAMETER	Equal to input / output number whose video parameter is requested	0	6, 24
30	LOCK FRONT PANEL	0 - Panel unlocked 1 - Panel locked	0	2
31	REQUEST WHETHER PANEL IS LOCKED	0	0	16
32 to 35	RESERVED	- - - -	- - - -	10
40	DIRECT MEMORY SAVE	Memory address	Data	20
42	AUDIO PARAMETER SETTINGS FOR INSTRUCTIONS 22, 24, 25	INPUT Bit: I0 - 0=input; 1=output I1 - Left I2 - Right	0 - Gain 1 - Bass 2 - Treble 3 - Midrange	24

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INSTRUCTION		DEFINITION FOR SPECIFIC INSTRUCTION		NOTE
#	DESCRIPTION	INPUT	OUTPUT	
43	VIDEO PARAMETER SETTINGS FOR INSTRUCTIONS 21, 23, 26	1 – Input 2 – Output	0 - video gain 1 - contrast 2 - brightness 3 - colour 4 - hue 5 - H-phase 6 - V-position	24
56	CHANGE TO ASCII	0	1 - SVS protocol 2 - Generic protocol	19
57	SET AUTO-SAVE	I3 - no save I4 - auto-save	0	12, 2
58	EXECUTE LOADED DATA	Set as 0, or as SETUP #.	1-Take 2-Cancel	22, 3
59	LOAD VIDEO DATA	Set equal to video input (0 = disconnect)	Set equal to video output (0 = to all the outputs)	22, 23
		(127 = load SETUP #)	or SETUP #	
60	LOAD AUDIO DATA	Set equal to audio input (0 = disconnect)	Set equal to audio output (0 = to all the outputs)	22, 23
		(127 = load SETUP #)	or SETUP #	
61	IDENTIFY MACHINE	1 - video machine name 2 - audio machine name 3 - video software version 4 - audio software version 5 - RS422 controller name 6 - RS422 controller version 7 - remote control name 8 - remote software version 9 - Protocol 2000 revision	0 - Request first 4 digits 1 - Request first suffix 2 - Request second suffix 3 - Request third suffix 10 - Request first prefix 11 - Request second prefix 12 - Request third prefix	13
62	DEFINE MACHINE	1 - number of inputs 2 - number of outputs 3 - number of setups	1 - for video 2 - for audio 3 - for SDI 4 - for remote panel 5 - for RS-422 controller	14
63	EXTENDED DATA	7 MSBs for INPUT data	7 MSBs for OUTPUT data	20

NOTES on the above table:

NOTE 1 - When the master switcher is reset, (e.g. when it is turned on), the reset code is sent to the PC. If this code is sent to the switchers, it will reset according to the present power-down settings.

NOTE 2 - These are bi-directional definitions. That is, if the switcher receives the code, it will perform the instruction; and if the instruction is performed (due to a keystroke operation on the front panel), then these codes are sent. For example, if the HEX code

01 85 88 83

was sent from the PC, then the switcher (machine 3) will switch input 5 to output 8. If the user switched input 1 to output 7 via the front panel keypad, then the switcher will send HEX codes:

41 81 87 83

to the PC.

When the PC sends one of the commands in this group to the switcher, then, if the instruction is valid, the switcher replies by sending to the PC the same four bytes that it was sent (except for the first byte, where the DESTINATION bit is set high).

NOTE 3 - SETUP # 0 is the present setting. SETUP # 1 and higher are the settings saved in the switcher's memory, (i.e. those used for Store and Recall).

NOTE 4 - The reply to a "REQUEST" instruction is as follows: the same instruction and INPUT codes as were sent are returned, and the OUTPUT is assigned the value of the requested parameter. The replies to instructions 10 and 11 are as per the definitions in instructions 7 and 8 respectively. For example, if the present status of machine number 5 is breakaway setting, then the reply to the HEX code

0B 80 80 85

would be HEX codes

4B 80 81 85

NOTE 5 – For the OUTPUT byte set as 6, the VIS source is the input selected using the OUTPUT byte. Similarly, for the OUTPUT byte set as 7, the VIS source is the output selected using the OUTPUT byte. Note also, that on some machines the sync source is not software selectable, but is selected using switches, jumpers, etc!

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NOTE 6 – If INPUT is set to 127 for these instructions, then, if the function is defined on this machine, it replies with OUTPUT=1. If the function is not defined, then the machine replies with OUTPUT=0, or with an error (invalid instruction code).

If the INPUT is set to 126 for these instructions, then, if possible, the machine will return the current setting of this function, even for the case that the function is not defined. For example, for a video switcher which always switches during the VIS of input #1, (and its VIS setting cannot be programmed otherwise), the reply to the HEX code

0A FE 80 81 (ie. request VIS setting, with INPUT set as 126_{dec})

would be HEX codes

4A FE 81 81 (ie. VIS setting = 1, which is defined as VIS from input #1).

NOTE 7 – Setting OUTPUT to 0 will return the VIS source setting as defined in instruction #7. Setting to 1 will return the input # or output # of the sync source (for the case where the VIS source is set as 6 or as 7 in instruction #7). Setting to 2 returns the vertical sync frequency (0 for no input sync, 50 for PAL, 60 for NTSC, 127 for error).

NOTE 8 - The reply is as in TYPE 3 above, except that here the OUTPUT is assigned with the value 0 if the setup is not defined / no valid input is detected; or 1 if it is defined / valid input is detected.

NOTE 9 - An error code is returned to the PC if an invalid instruction code was sent to the switcher, or if a parameter associated with the instruction is out of range (e.g. trying to save to a setup greater than the highest one, or trying to switch an input or output greater than the highest one defined). This code is also returned to the PC if an RS-232 instruction is sent while the machine is being programmed via the front panel. Reception of this code by the switcher is not valid.

NOTE 10 – This code is reserved for internal use.

NOTE 11 – For machines where the video and / or audio gain is programmable.

NOTE 12 - Under normal conditions, the machine's present status is saved each time a change is made. The "power-down" save (auto-save) may be disabled using this code. Note that whenever the machine is turned on, the auto-save function is set.

NOTE 13 - This is a request to identify the switcher/s in the system. If the OUTPUT is set as 0, and the INPUT is set as 1, 2, 5 or 7, the machine will send its name. The reply is the decimal value of the INPUT and OUTPUT. For example, for a 2216, the reply to the request to send the audio machine name would be (HEX codes):

7D 96 90 81 (i.e. 128_{dec}+ 22_{dec} for 2nd byte, and 128_{dec}+ 16_{dec} for 3rd byte).

If the request for identification is sent with the INPUT set as 3 or 4, the appropriate machine will send its software version number. Again, the reply would be the decimal value of the INPUT and OUTPUT - the INPUT representing the number in front of the decimal point, and the OUTPUT representing the number after it. For example, for version 3.5, the reply to the request to send the version number would be (HEX codes):

7D 83 85 81 (i.e. 128_{dec}+ 3_{dec} for 2nd byte, 128_{dec}+ 5_{dec} for 3rd byte).

If the OUTPUT is set as 1, then the ASCII coding of the lettering following the machine's name is sent. For example, for the VS-7588YC, the reply to the request to send the first suffix would be (HEX codes):

7D D9 C3 81 (i.e. 128_{dec}+ ASCII for "Y"; 128_{dec}+ ASCII for "C").

NOTE 14 - The number of inputs and outputs refers to the specific machine which is being addressed, *not* to the system. For example, if six 16X16 matrices are configured to make a 48X32 system (48 inputs, 32 outputs), the reply to the HEX code

3E 82 81 82 (ie. request the number of outputs)

would be HEX codes

7E 82 90 82

ie. 16 outputs

NOTE 15 – When the OVR bit (4th byte) is set, then the "video" commands have universal meaning. For example, instruction 1 (SWITCH VIDEO) will cause all units (including audio, data, etc.) to switch. Similarly, if a machine is in "FOLLOW" mode, it will perform any "video" instruction.

NOTE 16 - The reply to the "REQUEST WHETHER PANEL IS LOCKED" is as in NOTE 4 above, except that here the OUTPUT is assigned with the value 0 if the panel is unlocked, or 1 if it is locked.

NOTE 17 – For clean switching of RGBHV video, the "seamless switching" option may be used. The blanking period for the transition of the RGB sources may be set in this case, in steps of 25 milliseconds.

For example, to set for 350ms blanking time (14 steps), send HEX codes

07 8E A0 81

NOTE 18 – Delayed execution allows switching after a delay dictated by RS-232. To do this, the user sends instruction 7 with the "Set for delayed switch" option (64_{dec}) before sending the switch command (instruction 1) or pressing via front panel. The switch is not executed (unless timed-out) until the "Execute delayed switch" code is sent, or the "Set for delayed switch" code is sent again. (The mode is automatically cancelled after implementation of the switch if the "execute" command is used).

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For example, to connect input 4 to output 3 after a delay, send HEX codes

07	80	C0	81	(set for delayed switch)
01	84	83	81	(switch code)

then, after the required delay, send HEX codes

07	80	C1	81	(execute delayed switch)

to implement the switch.

NOTE 19 – After this instruction is sent, the unit will respond to the ASCII command set defined by the OUTPUT byte. The ASCII command to operate with the HEX command set must be sent in order to return to working with HEX codes.

NOTE 20 – When data (ie. the INPUT and/or OUTPUT bytes) of more than 7 bits is required, this instruction is sent before sending the instruction needing the additional bits. The data in this intruction then becomes the Most Significant Bits of that next instruction. For example, to set the audio gain (instruction 22) of output 3 to 681_{dec} ($2A9_{hex}$), you would first send HEX codes

3F	80	85	81

and then send HEX codes

16	83	A9	81.

To set the audio gain of output 6 to 10013_{dec} ($271D_{hex}$), first send HEX codes

3F	80	CE	81

followed by HEX codes

16	86	9D	81.

NOTE 21 – To store data in the non-volatile memory of the unit, eg. the EEPROM for saving SETUPS. The EEPROM address is sent using the INPUT byte, and the data to be stored is sent using the OUTPUT byte. To use this instruction, it is necessary to understand the memory map, and memory structure of the particular machine.

NOTE 22 – Instruction 59 and instruction 60 load data for sending to the crosspoint switcher (or for storing in a SETUP), ie. the data is "lined-up" to be executed later. Instruction 58 executes the loaded data.

NOTE 23 – If the INPUT byte is set as 127_{dec}, then the data stored in a SETUP is loaded. The SETUP # is in the OUTPUT byte.

NOTE 24 – Further information needed in instructions 21, 22, 25 and 26, is sent using instruction 42 – which is sent prior to the instruction. For example, to request the audio gain value of right input # 9, send hex codes

2A	84	80	81

and then send HEX codes

19	89	81	81.

NOTE 25 – For units which detect the validity of the video inputs, Instruction 16 will be sent whenever the unit detects a change in the state of an input (in real-time).
For example, if input 3 is detected as invalid, the unit will send the HEX codes

10	83	84	81

If input 7 is detected as valid, then the unit will send HEX codes

10	87	85	81.

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LIMITED WARRANTY

Kramer Electronics (hereafter *Kramer*) warrants this product free from defects in material and workmanship under the following terms.

HOW LONG IS THE WARRANTY

Labor and parts are warranted for seven years from the date of the first customer purchase.

WHO IS PROTECTED?

Only the first purchase customer may enforce this warranty.

WHAT IS COVERED AND WHAT IS NOT COVERED

Except as below, this warranty covers all defects in material or workmanship in this product. The following are not covered by the warranty:

1. Any product which is not distributed by Kramer, or which is not purchased from an authorized Kramer dealer. If you are uncertain as to whether a dealer is authorized, please contact Kramer at one of the agents listed in the Web site www.kramerelectronics.com.
2. Any product, on which the serial number has been defaced, modified or removed.
3. Damage, deterioration or malfunction resulting from:
   i) Accident, misuse, abuse, neglect, fire, water, lightning or other acts of nature
   ii) Product modification, or failure to follow instructions supplied with the product
   iii) Repair or attempted repair by anyone not authorized by Kramer
   iv) Any shipment of the product (claims must be presented to the carrier)
   v) Removal or installation of the product
   vi) Any other cause, which does not relate to a product defect
   vii) Cartons, equipment enclosures, cables or accessories used in conjunction with the product

WHAT WE WILL PAY FOR AND WHAT WE WILL NOT PAY FOR

We will pay labor and material expenses for covered items. We will not pay for the following:

1. Removal or installations charges.
2. Costs of initial technical adjustments (set-up), including adjustment of user controls or programming. These costs are the responsibility of the Kramer dealer from whom the product was purchased.
3. Shipping charges.

HOW YOU CAN GET WARRANTY SERVICE

1. To obtain service on you product, you must take or ship it prepaid to any authorized Kramer service center.
2. Whenever warranty service is required, the original dated invoice (or a copy) must be presented as proof of warranty coverage, and should be included in any shipment of the product. Please also include in any mailing a contact name, company, address, and a description of the problem(s).
3. For the name of the nearest Kramer authorized service center, consult your authorized dealer.

LIMITATION OF IMPLIED WARRANTIES

All implied warranties, including warranties of merchantability and fitness for a particular purpose, are limited in duration to the length of this warranty.

EXCLUSION OF DAMAGES

The liability of Kramer for any effective products is limited to the repair or replacement of the product at our option. Kramer shall not be liable for:

1. Damage to other property caused by defects in this product, damages based upon inconvenience, loss of use of the product, loss of time, commercial loss; or:
2. Any other damages, whether incidental, consequential or otherwise. Some countries may not allow limitations on how long an implied warranty lasts and/or do not allow the exclusion or limitation of incidental or consequential damages, so the above limitations and exclusions may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights, which vary from place to place.

NOTE: All products returned to Kramer for service must have prior approval. This may be obtained from your dealer.

This equipment has been tested to determine compliance with the requirements of:

EN-50081:	"Electromagnetic compatibility (EMC); generic emission standard. Part 1: Residential, commercial and light industry"
EN-50082:	"Electromagnetic compatibility (EMC) generic immunity standard. Part 1: Residential, commercial and light industry environment".
CFR-47:	FCC Rules and Regulations: Part 15: "Radio frequency devices Subpart B Unintentional radiators"

CAUTION!

- Servicing the machines can only be done by an authorized Kramer technician. Any user who makes changes or modifications to the unit without the expressed approval of the manufacturer will void user authority to operate the equipment.
- Use the supplied DC power supply to feed power to the machine.
- Please use recommended interconnection cables to connect the machine to other components.

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For the latest information on our products and a list of Kramer distributors, visit our Web site: www.kramerelectronics.com, where updates to this user manual may be found.
We welcome your questions, comments and feedback.

Safety Warning:
Disconnect the unit from the power supply before opening/servicing.

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